

PATENT

IN THE CLAIMS:

Please amend, cancel or add claims as indicated.

- 5 1. (original) A back-illuminated image sensor comprising:
a semiconductor base of a first conductive type;
a plurality of charge accumulating units of a second conductive type different from said first
conductive type, formed on a second-plane side which is the backside of a first plane of said semiconductor
base, said charge accumulating units which accumulate, on a pixel-by-pixel basis, signal charges generated
10 by an energy ray incident from the second-plane side;
a charge transfer unit formed on the first-plane side of said semiconductor base facing said charge
accumulating units, the charge transfer unit which transfers said signal charges to be read;
a charge transport unit which transports said signal charges accumulated in said charge
accumulating units to said charge transfer unit; and
15 a depletion prevention layer formed closer to said second-plane side than said charge accumulating
units, the depletion prevention layer which prevents a depletion region around said charge accumulating
units from reaching said second plane.
2. (original) An image sensor according to claim 1, wherein said depletion prevention layer is of said
first conductive type.
- 20 3. (original) An image sensor according to claim 2, wherein said depletion prevention layer has
impurity distribution that allows said energy ray to pass through and impurity concentration rate that
prevents said depletion region from reaching said second plane.
4. (original) An image sensor according to claim 2, wherein said charge accumulating units are fully
depleted at completion of charge transportation.
- 25 5. (original) A back-illuminated image sensor comprising:
a semiconductor base of a first conductive type;
a plurality of charge accumulating units of a second conductive type different from said first
conductive type, formed on a second-plane side which is the backside of a first plane of said semiconductor

PATENT

base, said charge accumulating units which accumulate, on a pixel-by-pixel basis, signal charges generated by an energy ray incident from the second-plane side;

a charge transfer unit formed on the first-plane side of said semiconductor base facing said charge accumulating units, the charge transfer unit which transfers said signal charges to be read;

5 a charge transport unit which transports said signal charges accumulated in said charge accumulating units to said charge transfer unit; and

an invalid charge discharging unit which drives said charge transfer unit to discharge an invalid charge while said charge accumulating units accumulate said signal charges.

6. (original) A back-illuminated image sensor comprising:

10 a semiconductor base of a first conductive type;

a plurality of charge accumulating units of a second conductive type different from said first conductive type, formed on a second-plane side which is the backside of a first plane of said semiconductor base, said charge accumulating units which accumulate, on a pixel-by-pixel basis, signal charges generated by an energy ray incident from the second-plane side;

15 a charge transfer unit formed on the first-plane side of said semiconductor base facing said charge accumulating units, the charge transfer unit which transfers said signal charges to be read;

a charge transport unit which transports said signal charges accumulated in said charge accumulating units to said charge transfer unit; and

20 a dark current suppressing unit which approximates a potential of the first-plane side of said charge transfer unit to a substrate potential to suppress dark current flowing in from said first-plane side, at least during a predetermined period while said charge accumulating units accumulate said signal charges.

7. (Currently Amended) A back-illuminated image sensor comprising:

a semiconductor base of a first conductive type;

25 a plurality of charge accumulating units of a second conductive type different from said first conductive type, formed on a second-plane side which is the backside of a first plane of said semiconductor base, said charge accumulating units which accumulate, on a pixel-by-pixel basis, signal charges generated by an energy ray incident from the second-plane side;

a charge transfer unit formed on the first-plane side of said semiconductor base facing said charge accumulating units, the charge transfer unit which transfers said signal charges to be read;

PATENT

a charge transport unit which transports said signal charges accumulated in said charge accumulating units to said charge transfer unit; and

an excessive charge discharging unit which overflows an excessive charge into said charge transfer unit in a vertical direction, from the charge accumulating units on the second-plane side to the charge

5 transfer unit on the first-plane side and drives said charge transfer unit to discharge said excessive charge, said excessive charge occurring due to exceeding a saturation charge amount of said charge accumulating units.

8- 11. (Canceled)

12. (previously presented) A back-illuminated image sensor comprising:

10 a semiconductor base of a first conductive type;

a plurality of charge accumulating units of a second conductive type different from said first conductive type, formed on a second-plane side which is the backside of a first plane of said semiconductor base, said charge accumulating units which accumulate, on a pixel-by-pixel basis, signal charges generated by an energy ray incident from the second-plane side;

15 a charge transfer unit formed on the first-plane side of said semiconductor base facing said charge accumulating units, the charge transfer unit which transfers said signal charges to be read;

a charge transport unit which transports said signal charges accumulated in said charge accumulating units to said charge transfer unit; and

20 a barrier region provided on at least a part of transport paths of said signal charges formed between said charge accumulating units and said charge transfer unit, the barrier region which creates a peak of a potential barrier to block progress of said signal charges when no charge is to be transported and ensures full transportation of said signal charges by eliminating the peak of said potential barrier by said charge transport unit when a charge is transported, and wherein

25 said barrier region is formed by introducing impurities of said first conductive type into said semiconductor base.

13. (original) An image sensor according to claim 12, wherein a concentration rate of said impurities introduced into said barrier region is set higher than a concentration rate of said semiconductor base.

14. (Previously Presented) An image sensor according to claim 12, wherein said barrier region is provided in contact with said charge transfer unit.

PATENT

15. (Previously Presented) An image sensor according to claim 12, wherein at the time of no charge transportation, said potential barrier in said barrier region is set lower than a potential barrier between adjoining charge accumulating units according to the view points of the polarity of said signal charges.

16-20. (canceled)

5 21. (Currently Amended) A back-illuminated image sensor ~~comprising~~ according to claim 5, wherein:

~~a semiconductor base of a first conductive type;~~

~~a plurality of charge accumulating units of a second conductive type different from said first conductive type, formed on a second plane side which is the backside of a first plane of said semiconductor base, said charge accumulating units which accumulate, on a pixel to pixel basis, signal charges generated by an energy ray incident from the second plane side;~~

10 said charge transfer unit includes a charge transfer channel formed on the first-plane side of said semiconductor base facing said charge accumulating units, the charge transfer channel which transfers said signal charges; and

transfer electrodes, which apply a transfer voltage to said charge transfer channel, that are periodically distributed at a ratio of substantially less than three per one of said charge accumulating units and are distributed along a direction the charge transfer channel performs charge transfer; and

~~a split~~ said charge transport unit which transports signal charges from said charge accumulating units to said charge transfer channel, said transporting being performed at phase intervals of said transfer electrodes;

20 ~~the split transport unit which transports, the transport being done for one screenful of signal charges at a plurality of times while shifting the phases of positions where signal charges are to be transported; and, wherein~~

~~a split~~ said charge transfer unit which drives said transfer electrodes in multi-phase, each time said split charge transport unit transports signal charges to said charge transfer channel, and the split transfer unit which reads out one screenful of signal charges at a plurality of times, wherein

25 ~~said transfer electrodes are provided in a charge transfer direction of said charge transfer channel, in proportion of substantially two or less said transfer electrodes per one said charge accumulating unit.~~

22-61. (canceled)

PATENT

62. (New) A back-illuminated image sensor according to claim 5, wherein:

said charge transfer unit is a CCD formed by overlapping a CCD diffusion layer, an insulating film, and CCD electrodes on the first-plane side; and

said invalid charge is discharged through the CCD diffusion layer, by the voltage drive of the CCD
5 electrode formed on said first-plane side.